of the chromosomes in synapsis is such as to prevent any subsequent separation, the result being that no sex-cells can be organised, since the essential condition of a qualitative separation of the chromatin is not fulfilled.

"The Secreto-motor Effects in the Cat's Foot Studied by the Electrometer." By AUGUSTUS D. WALLER, M.D., F.R.S. Received November 17,—Read November 19, 1903. Received in revised form January 16, 1904.

In a previous communication* it was stated that the electrical signs of secreto-motor action by tetanisation of the sciatic nerve are demonstrable in the pads of a cat's foot after death, best so during the second half-hour after death, when the action of the nerve upon muscles of the limb has ceased.

The subsequent study of these effects, by means of electrometer records, has brought out with great distinctness the chief classical events with which we are familiar in the case of the contraction of voluntary muscle, viz., the latency and course of a single response to a single stimulus, the super-position of two or more responses and the composition of tetanus, summation of stimuli, fatigue and recovery, and the staircase phenomenon. The difference between the muscular and the secreto-motor series of phenomena is principally a difference of time, the former being about 100 times more rapid than the latter.

I may preface the description by stating that I have experimentally satisfied myself that the electrical effects are in reality of glandular origin. The response is completely abolished by atropine, and it is restricted to the pads (glandular) of the skin, being completely absent from the hairy (non-glandular) skin, *i.e.*, it is not a pilo-motor concomitant.

The description itself will be best given by means of the following electrometer records of:—

1. A single response to show the latent period and duration of the response.
2. A series of single responses to show staircase phenomenon.
3. A series of four responses to show composition of tetanus.
4. A series exhibiting *post-mortem* decline.

* 'Proc. Roy. Soc.,' November, 1901, "On Skin-currents. Part II.—Observations on Cats." The electrical effect of indirect excitation is always ingoing through the skin. This direction has been conventionally indicated throughout this paper by a downward movement of the mercury column.

5. A series to exhibit the relation between magnitude of stimulation and magnitude of response.
6. A single response before and after tetanus to illustrate "facilitation" (Bahnung).
7. A single response before and after tetanus to illustrate fatigue.
8. A series to illustrate summation of stimuli.
9. A series to show the difference between infrequent and frequent stimuli.

No special comment upon the records appears to be necessary, beyond, perhaps, a remark to the effect that "summation of stimuli," as distinguished from "summation of effects," is, by reason of the great length of the latent period, a particularly evident phenomenon. The latent period itself has its seat at the organ of intermediation between nerve and secreting cell, as is shown by the absence of demonstrable lost time to direct excitation and along the nerve itself. The declining excitability of the secreto-motor nerve fibres is very evidently in the centrifugal direction, stimulation of the nerve nearer to the periphery being effective after stimulation further from the periphery has ceased to be effective.

Similar effects are obtainable on nerve-skin preparations of the frog, "summation of stimuli" and "staircase effect" being, as in the case of the cat, particularly evident.

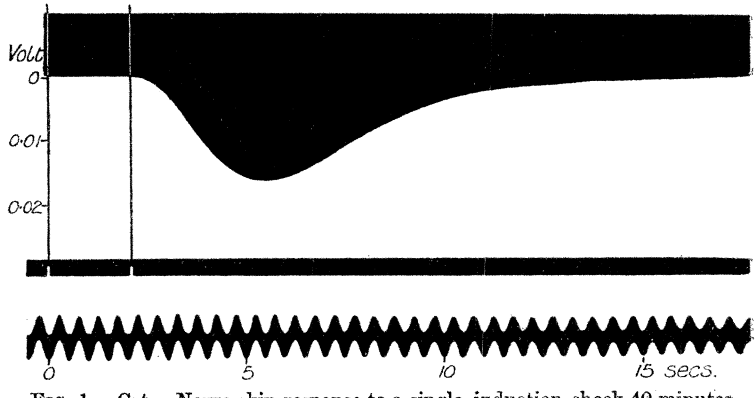

FIG. 1.—Cat. Nerve-skin response to a single induction shock 40 minutes *post-mortem*.

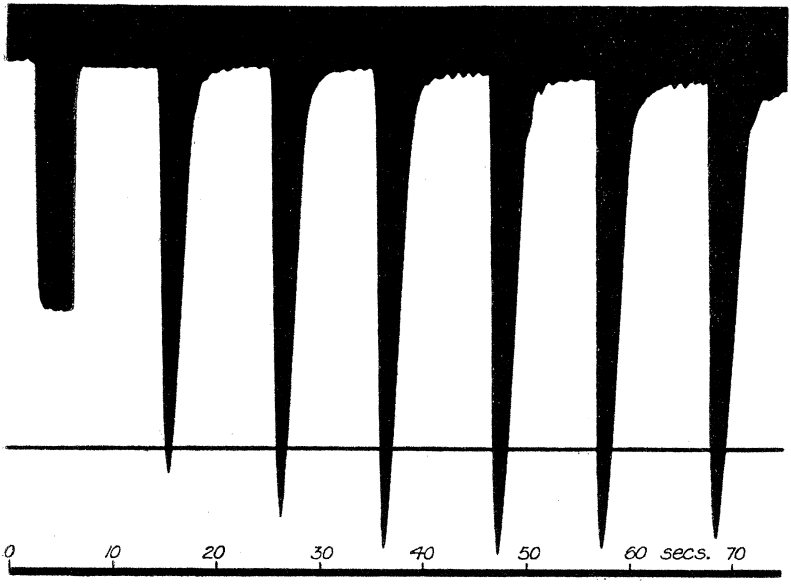

FIG. 2.—Cat. Six nerve-skin responses to single induction shocks of uniform strength. Staircase increase from 0·0165 to 0·0195 volt. (The initial deflection is that of a standard $\frac{1}{100}$th volt.)

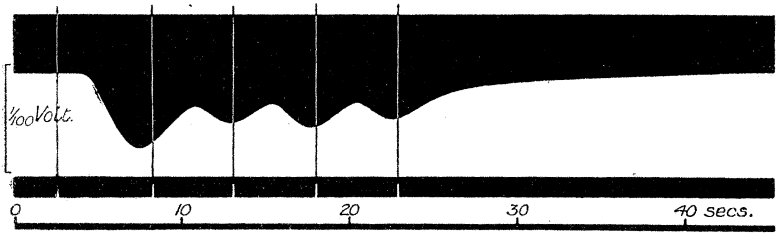

FIG. 3.—Cat. 35 minutes *post-mortem*. Imperfect tetanus by four instantaneous make-break induction shocks at intervals of about 5 seconds.

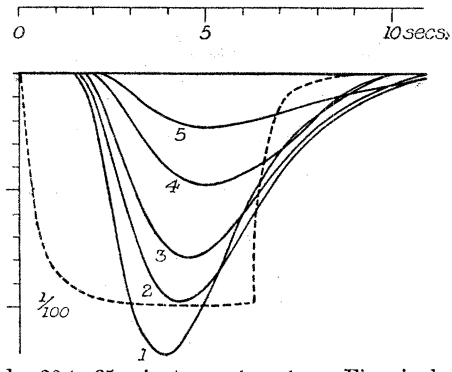

FIG. 4.—Cat's pad. 30 to 65 minutes *post-mortem*. Five single responses to excitation of the sciatic nerve by instantaneous make-break induction shocks at intervals of approximately 10 minutes. The dotted line shows the curve given by $\frac{1}{100}$th volt through the preparation and electrometer.

Time *post-mortem*.	Latency.	Magnitude of response.
30 mins.	1·4 sec.	0·0123 volt.
40 ,,	1·6 ,,	0·0100 ,,
48 ,,	1·7 ,,	0·0080 ,,
55 ,,	1·8 ,,	0·0048 ,,
65 ,,	2·0 ,,	0·0018 ,,

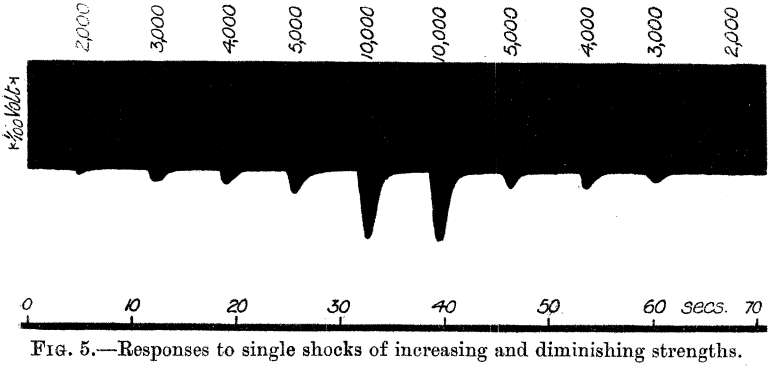

FIG. 5.—Responses to single shocks of increasing and diminishing strengths. 1 hour *post-mortem*.

Strength of stimulation.	Voltage of response.	Strength of stimulation.	Voltage of response.
2,000	0·0005	10,000	0·0090
3,000	0·0015	5,000	0·0015
4,000	0·0020	4,000	0·0015
5,000	0·0030	3,000	0·0010
10,000	0·0085	2,000	Nil

N.B.—This electrometer record is not very satisfactory, as the magnification was taken too low. The following series of numbers observed without record with higher magnification 45 minutes *post-mortem* is a better one :—

Strength of stimulation.	Voltage of response.	Strength of stimulation.	Voltage of response.
1,000	Nil	4,000	0·0065
2,000	0·0015	5,000	0·0125
3,000	0·0035	10,000	Off scale

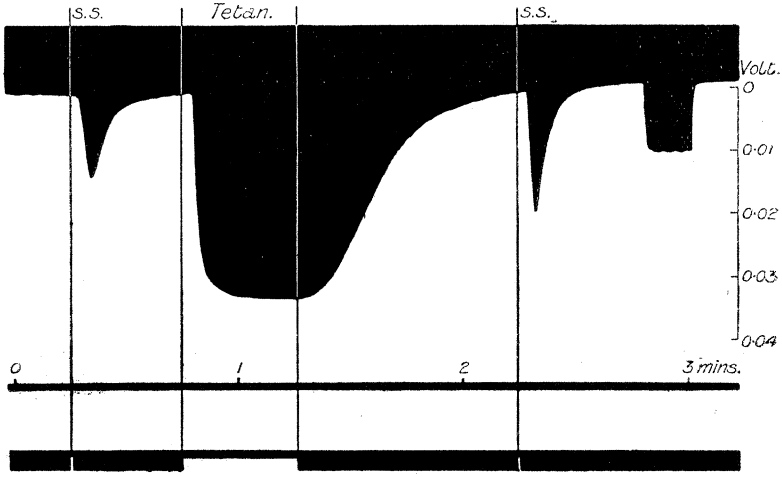

FIG. 6.—Effects of a single shock, S.S., before and after tetanisation for ½ minute.

Before ..... = 0·0115 volt.
(During tet. ..... = 0·0300 „)
After ..... = 0·0155 „

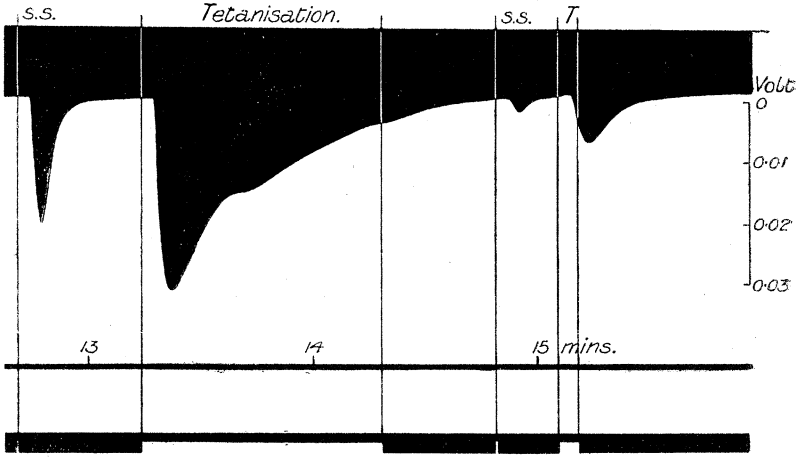

FIG. 7.—Effects of a single shock, S.S., before and after strong tetanisation for 1 minute.

Before ..... = 0·0183 volt.
(During tet. ..... = 0·0283 „)
After..... = 0·0017 „

A second tetanisation at T gives only 0·0067 volt.

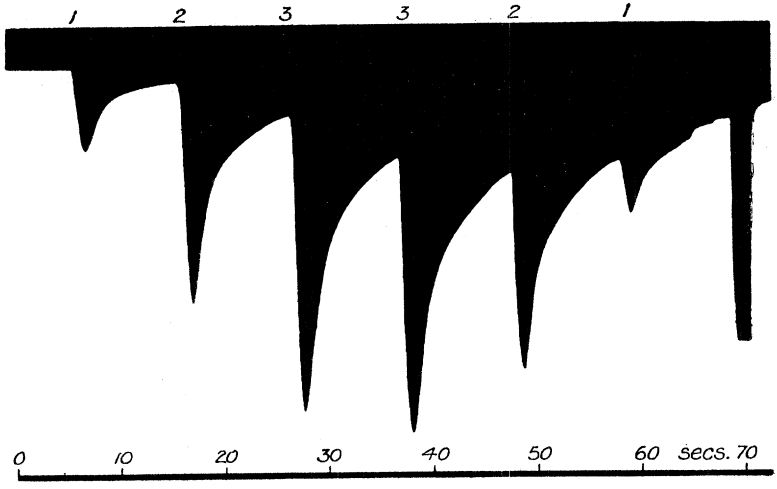

FIG. 8.—To illustrate summation of stimuli. Effects of 1, 2, 3, 3, 2, 1 instantaneous make-break shocks.

Response to	1	shock.....	= 0·0035 volt.
,,	2	,, ...	= 0·0097 ,,
,,	3	,, ...	= 0·0130 ,,
,,	3	,, ...	= 0·0120 ,,
,,	2	,, ...	= 0·0087 ,,
,,	1	,, ...	= 0·0023 ,,

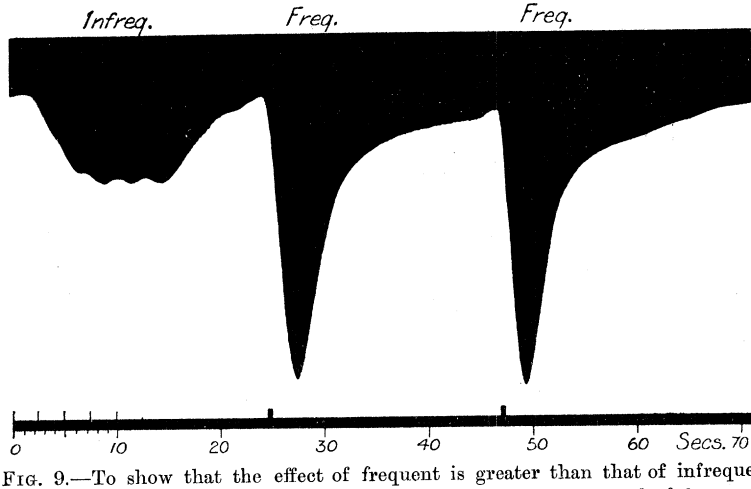

FIG. 9.—To show that the effect of frequent is greater than that of infrequent stimuli. The first response, aroused by five shocks at an interval of 2 seconds, is an incomplete tetanus with a maximum value of 0·0040 volt. The second and third responses are each to five shocks at an interval of about $\frac{1}{10}$th second, and reach maximum values of 0·0123 and 0·0120 volt.

Addendum, December 10, 1903.

The latent period and the duration of the response are smaller at high temperature, greater at low temperature. And under similar conditions the voltage of the response is greater at high than at low temperature. These three points are illustrated by fig. 10 of a single response from the left foot enclosed in a cool chamber at $+9°$, and from the right foot enclosed in a warm chamber at $+35°$.

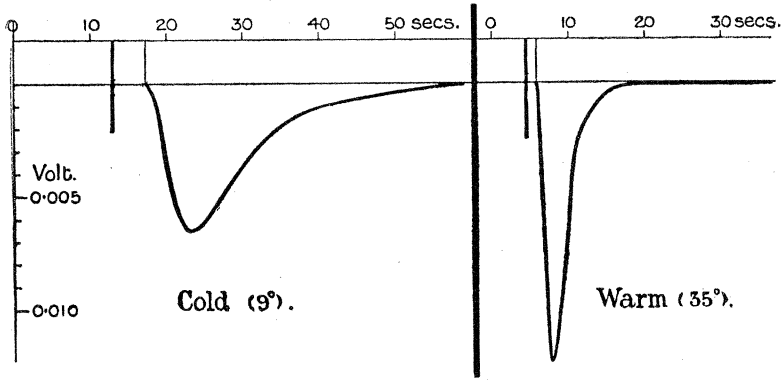

FIG. 10.—Cat. Nerve-skin response to a single induction shock at 9° and at 35° of the surrounding air.

	Cold.	Warm.
Latent period.....	4 secs.	1·5 secs.
Duration of response....	30 „	10·0 „
Maximum voltage.....	0·0065 volt.	0·0122 volt.

The progressive alterations exhibited by fig. 10 are no doubt influenced by the falling temperature that normally occurs in a limb after arrest of the circulation.